CHAPTER 120

Road Safety Rating using iRAP

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ABSTRACT

India ranks among the highest in the world for road accident fatalities, with over 150,000 deaths and millions of injuries recorded annually. Road accidents account for 13% of global road traffic deaths, posing a significant public health and economic challenge. Contributing factors include poor road infrastructure, lack of pedestrian and cyclist facilities, unsafe driving behaviours, and inadequate enforcement of traffic laws. Despite technological advancements, road safety remains a critical issue, with vulnerable road users such as pedestrians, motorcyclists, and cyclists disproportionately affected. This project addresses these challenges through the application of the International Road Assessment Programme (iRAP) methodology. Using iRAP, the study identifies hazardous sections of a selected national highway, evaluates its safety performance, and prioritizes safety improvements. The methodology includes the development of actionable countermeasures based on star ratings for safety. The expected outcomes include the development of a safer road network, reduced accident rates, and enhanced safety for diverse road user categories. By employing data-driven strategies and aligning with global best practices, this research aims to support the broader goal of achieving higher safety rating for national highways in India, promoting sustainable and secure road environments.

Keywords: iRAP; Road safety; Star rating.

1.0 Introduction

1.1 Introduction to road condition

Every day, millions of people travel, run errands, and commute on roadways, but these routes can be hazardous due to a lack of proper safety precautions. Road accidents continue to be a major source of death and injury globally despite technological advancements because of things like speeding, inebriated or distracted driving, human error, inadequate infrastructure, and defective vehicles. Every year, 150,785 persons in India lose their lives in traffic accidents, which cost the country's economy over $75 billion, or 4% of GDP. According to IndiaRAP's analysis of 17,600 km of high-risk roads, 99% of them do not have bike lanes. There are no pathways on 95% of routes.

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Motorcycle facilities are absent from 99 percent of heavy motorcycle traffic routes. Fifty-five percent of routes that are 80 km/h or faster are undivided. Roadside hazards are present on 89% of curves at 80 km/h or faster. Roundabouts, turn lanes, and interchanges are absent from 87% of high-speed intersections. Over 7.6 million lives could be saved and serious injuries might be avoided in the next 20 years if 10% of India's most hazardous roads were upgraded to three stars or better.

1.2 International road assessment programme (iRAP)

By offering unbiased evaluations and suggestions, the International Road Assessment Programme (iRAP) is committed to enhancing road safety on a global scale. Its main goal is to create a "safe system" by analyzing driving behavior, routes, and automobiles. Over 70 countries, including 10 Indian states, have participated in iRAP's assessments, which are carried out in partnership with institutions such as the World Bank's GRSF. According to inspections conducted between 2010 and 2014, the majority of roads in states including Uttar Pradesh, Telangana, Rajasthan, Kerala, Tamil Nadu, Haryana, and Andhra Pradesh were rated as low safety (one or two stars). iRAP assists in directing investments and influencing driving behavior to lower the number of fatalities and injuries globally by identifying high-risk regions.

1.3 Objectives of the study

- To analyze road characteristics of 5KM stretch from Bhujbal Vasti Chowk to Sus Road Baner.
- To conduct safety performance assessment using iRAP VIDA Software.
- To recommend safety measures for good ratings.

2.0 Literature Review

Table 1: Summary of Literature Review

No.	Title	Authors	Key Findings
1	Roadway Safety Assessment and Star Rating using iRAP	Sunil, Abhishek Sharma	Assesses SH-11A (Jind-Kaithal) using iRAP to improve safety and achieve a minimum 3-star rating.
2	BIM & Road Safety	Emidio Sabatoa, Fabrizio D'Amicoa, Antonino Tripodi, Paola Tiberi	Integrates BIM with iRAP for automated safety assessments, improving efficiency in road design and asset management.
3	Road Infrastructure Inspection & iRAP	Lauragrazia Daidone *et al.*	Highlights EuroRAP/iRAP methodologies for road safety, emphasizing Safe System approaches and collaborative improvements.

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4	Road Safety and iRAP in Bangladesh	Hoque M, Smith G, Rahman M	iRAP reveals low safety ratings on highways, stressing cost-effective countermeasures for vulnerable road users.
5	Road Safety Audit & Black Spot Identification in India	Sadguna Nuli, Katkam Rohan, Chenreddy Joshnavi	Emphasizes RSA and black spot identification to reduce accident-prone areas and enhance road safety.
6	Road Safety Evidence & Gap Map	Dinesh Mohan *et al.*	Identifies global road safety challenges, advocating evidence-based interventions to reduce traffic injuries.
7	Safety Factors on Two-Lane Highways in India	Sudipa Chatterjee *et al.*	RSA highlights poor road design and user behavior risks, recommending infrastructure upgrades and speed management.
8	COVID-19 Impact on Driving Behaviour & Safety	Eva Michelaraki *et al.*	Lockdowns led to higher speeds and increased risky driving behavior, requiring new safety regulations.
9	Road Safety in India: A Public Health Concern	Shradha S Parsekar *et al.*	Human negligence is a key factor in accidents; education, enforcement, and infrastructure improvements are crucial.
10	Road Safety Challenges in Nepal & India	Om Prakash Giri *et al.*	Advocates multi-stakeholder collaboration for road safety improvements in diverse geographical terrains.
11	Exposure & Speed in Road Safety	Xin PEI *et al.*	Speed increases crash severity; time spent driving also affects crash risks, requiring balanced analysis.

3.0 Methodology

Roads are surveyed, data is gathered, and a safety rating indicating crash risk is assigned as part of a framework for improving road safety. To lessen the chance of a collision, several countermeasures are suggested based on the rating, such as putting rumble strips, adding shoulders, or upgrading signage.

3.1 Framework

The framework represents a structured approach to road safety assessment with a focus on star rating and road improvement recommendations. Below is a detailed breakdown of the process:

3.1.1 Data collection and initial assessment

- *Road survey:* Collects real-world data on existing road conditions.
- *Road coding:* Categorizes and encodes the collected data for further analysis.
- *Supporting data:* Additional relevant data such as traffic volume, and road geometry.

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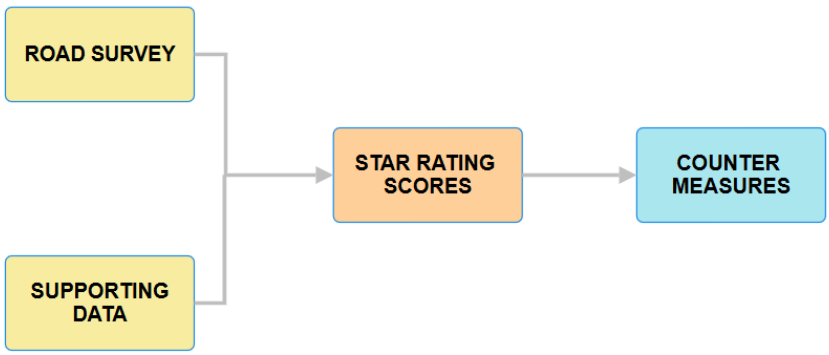
Figure 1: iRAP Methodology Framework



3.1.2 Evaluation and condition analysis

- *Star rating scores:* A systematic way to assess road safety using iRAP. **A**ssigns a safety rating (typically 1-5 stars) based on road conditions and risk factors.

3.1.3 Safety recommendation

- *Countermeasure generation:* Identifies possible safety improvements (e.g., better road markings, pedestrian crossings, barriers).

3.2 Steps involved iRAP Vida road safety assessment process

Data collection on road infrastructure, traffic dynamics, and operational factors is the initial step in the assessment process. Road alignment, surface quality, paved shoulders, safety barriers, rumble strips, and speed control techniques are important components. Additionally taken into account are traffic statistics such as pedestrian flows and Annual Average Daily Traffic (AADT).

3.3 Categorization into safety modules

The collected data is then classified into distinct safety modules to enable a structured evaluation. The Roadside Hazard Assessment examines the proximity of fixed objects, such as safety barriers placed within a 1–5-meter range. Shoulder conditions, including narrow paved shoulders and the presence of rumble strips, are also evaluated.

3.4 Risk scoring and weighting

Based on crash data and the severity of injuries, iRAP provides weighted risk scores to road elements, producing star ratings (1–5) for cyclists, motorcyclists, pedestrians, and car occupants. International injury-prevention databases are the source of these scores.

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Table 2: Categorization into Safety Modules

Roadside Attributes	
Roadside severity driver-side distance	1 to<5m
Roadside severity - driver-side object	Safety barrier - metal
Roadside severity - passenger-side distance	1 to<5m
Roadside severity. Passenger-side Object	Safety barrier metal
Shoulder rumble strips	Not present
Paved shoulder - driver-side	Narrow (>=0m to < 1m)
Midblock Attributes	
Carriageway label	Carriageway A Of a divided carriageway road
Upgrade cost	Medium
Median type	Physical median width >=0m to < 1 m
Centerline rumble strips	Not present
Number of lanes	Three
Lane width	Medium (>= 2.75m to < 3.25m)
Intersection Attributes	
Intersection type	None
Intersection channelization	Not present
Intersecting road volume	None
Intersection quality	Not applicable
Property access points	None
Flow Attributes	
Vehicle flow (AADT)	36332
Motorcyclist %	41%-60%
Pedestrian peak hour flows across the road	6 to 25
Pedestrian peak hour flow along the road driver-side	6 to 25
Pedestrian peak hour flows along the road passenger-side	6 to 25
VRU Facilities and land use Attributes	
Land use - driver-side	Commercial
Land use - passenger-side	Commercial
Area type	Urban rural town or village
Pedestrian crossing facilities inspected road	No facility
Pedestrian crossing quality	Not applicable
Pedestrian crossing facilities - intersecting road	No facility
Speeds Attributes	
Speed limit	80km/h
Differential speed limits	Not present
Speed management I traffic calming	Not present
Operating Speed (85th percentile)	70kmJh

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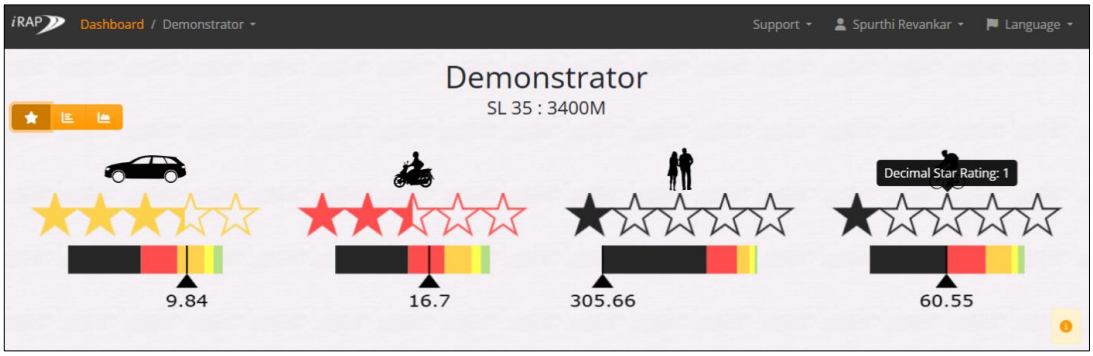
Figure 2: Demonstrator Rating



4.0 Data Analysis and Findings

Figure 3: Selection of Study Area

4.1 Selection of study area

A 5 km road segment from Bhujbal Vasti Chowk to Sus Road Baner was surveyed using photo imagery and iRAP VIDA software. Historical speed data analysis showed no pace or warning signs, and vehicles didn't slow at junctions. The road was divided into 100-meter segments for consistent evaluation. The Star Rating Demonstrator assessed features like roadside conditions, intersections, vulnerable road user facilities, land use, and speed data. A 5

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4.2 iRAP star rating of 5km stretch from Bhujbal Vasti chowk to Sus road Baner

Table 3: iRAP Star Rating of 5 KM stretch from Bhujbal Vasti Chowk to Sus Road

SL NO.	DISTANCE	BEFORE - CAR	BEFORE - BIKE	BEFORE - PEDESTRIAN	BEFORE - BICYCLIST	AFTER - CAR	AFTER - BIKE	AFTER - PEDESTRIAN	AFTER - BICYCLIST
1	0 m	3.9	3.6	1	2.9	4.6	3.4	3	5
2	100 m	3.5	3.6	1	2.2	5	4.6	3	5
3	200 m	3.4	3.4	1	1	5	4.2	3	5
4	300 m	3.5	3.4	1	1	3.9	2.8	3	5
5	400 m	3.4	2.8	1	1	3.8	3.5	2.8	5
6	500 m	3.1	2.7	1	1	3.8	3.5	2.8	5
7	600 m	3.1	2.7	1	1	3.5	3.5	2.8	5
8	700 m	4.9	4.4	2	3.3	5	4.5	3.6	5
9	800 m	3.3	2.5	1	1	3.5	2.5	2.5	4.9
10	900 m	3.3	2.5	1	1	3.5	2.9	2.6	4.9
11	1000 m	2.9	2.3	1	1	3.7	2.6	2.9	5
12	1100 m	2.9	2.3	1	1	3.3	3	2.9	5
13	1200 m	2.9	2.4	1	1	3.3	3	2.9	5
14	1300 m	2.9	2.4	1	1	3.3	3	2.9	5
15	1400 m	3.3	2.6	1	1	3.3	3.3	2.9	5
16	1500 m	3.5	2.6	1	1	3.7	3.3	2.7	5
17	1600 m	3.5	2.6	1	1	3.7	3.3	2.7	5
18	1700 m	3.5	2.6	1	1	3.7	3.3	2.9	5
19	1800 m	3.5	2.6	1	1	3.7	3.3	2.9	5
20	1900 m	3.5	2.6	1	1	3.4	3.3	2.9	5
21	2000 m	2.7	2.1	1	1	3.4	3.3	4.5	5
22	2100 m	3.5	2.6	1	1	3.7	3.4	3.2	5
23	2200 m	3	2.4	1	1	3.7	3.4	3.2	5
24	2300 m	3	2.4	1	1	3.7	3.4	3.2	5
25	2400 m	3.5	2.7	1	1	3.7	3.4	3.2	5
26	2500 m	3.5	2.7	1	1	3.7	3.5	3.2	5
27	2600 m	3.3	2.6	1	1	3.7	3.5	3.2	5
28	2700 m	3.3	2.5	1	1	3.7	3.4	3	5
29	2800 m	2.8	2.2	1	1	3.4	3.2	2.9	5
30	2900 m	3.3	2.6	1	1	3.7	3.4	2.9	5
31	3000 m	3.4	2.8	1	1	3.7	3.4	3	5
32	3100 m	3.3	2.6	1	1	3.7	3.4	3	5
...	...	...	...	...	...	...	...	...	...
51	5000 m	2.8	2.2	1	1	3.5	3.1	3.1	5
AVERAGE RATING		**3.4**	**2.7**	**1**	**1.5**	**3.8**	**3.4**	**3.1**	**5**

4.3 Star rating analysis iRAP Vida road analysis

4.3.1 Star rating table (raw) –present road condition

Table shows clearly that only 88 % of the roads for vehicle occupants, 12% for motorcyclists, is rated 3 star or above, rest is below 3 Star.

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Table 4: Star Rating Table – Present Road Condition

Star Rating	Vehicle Occupant		Motorcyclist		Pedestrian		Bicycle	
	Length (Km)	Percent %	Length (Km)	Percet %	Length (Km)	Percent %	Length (Km)	Percent %
5 STARS	0.3	6%	0	0%	0	0%	0	0%
4 STARS	0.1	2%	0.1	2%	0	0%	0	0%
3 STARS	4	80%	0.5	10%	0	0%	0.1	2%
2 STARS	0.6	12%	4.4	88%	0.1	2%	1.9	38%
1 STAR	0	0%	0	0%	4.9	98%	3	60%
TOTALS	5	100%	5	100%	5	100%	5	100%

4.4 Star rating table (Raw) – After recommendation's from iRAP Vida

This table clearly shows that around 100 % of the roads for vehicle occupants are rated 3-star or above, and about 100% of the roads for motorcyclists are rated safe after implementing the countermeasures into the iRAP VIDA Software. There is a significant increase in the safety characteristics of the roads in comparison to the existing situation.

Table 5: Star Rating Table- After Recommendation's from iRAP Vida

Star Rating	Vehicle Occupant		Motorcyclist		Pedestrian		Bicycle	
	Length (Km)	Percent %	Length (Km)	Percet %	Length (Km)	Percent %	Length (Km)	Percent %
5 STARS	0.5	10%	0	0%	0	0%	4.8	96%
4 STARS	0	0%	0.5	10%	0.1	2%	0.2	4%
3 STARS	4.5	90%	4.5	90%	2.9	58%	0	0%
2 STARS	0	0%	0	0%	2	40%	0	0%
1 STAR	0	0%	0	0%	0	0%	0	0%
TOTALS	5	100%	5	100%	5	100%	5	100%

4.5 Results and observations in general

Recommendations include widening shoulders and installing speed-calming measures. Safety performance is evaluated by calculating Star Rating Scores for every 100-meter segment for four user groups: Vehicle occupants, Motorcyclists, Pedestrians, and Bicyclists.

4.6 Strategic implications and safety enhancements

- *Narrow/No Shoulder:* Adding rumble strips, using wide medians, and providing designated shoulders on both sides can improve safety and enforce correct lane discipline. Narrow or missing shoulders on expressways, particularly in ghat sections, reduce emergency stopping space.

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- *Poor/ineffective road signage:* Clear road markings and signage are essential for guiding drivers and ensuring timely decisions. Issues include poor visibility, incorrect placement, and lack of multilingual information. Signs should be installed at least 1 km before action points, using clear symbols or multilingual text (Marathi, Hindi, English). Repeating signs at least three times improves effectiveness.
- *Damaged curb stones:* Black and yellow curb stones along the borders of motorways can seriously damage cars in collisions, putting them at risk of rollovers.
- *Infrastructure for pedestrians and cyclists:* By reducing collisions with cars, crossings, walkways, and bike lanes increase safety for non-motorized users.
- *Road markings & speed control:* Safety and compliance are improved by clear markings, signage, and speed control devices like bumps and cameras.
- *Physical safety interventions:* Improved lighting, rumble strips, and guardrails lower collision rates and increase visibility at night.
- *Modifications to traffic flow:* Improving traffic flow and safety can be achieved by adding median barriers and widening lanes.
- *Projected safety outcomes:* With focused interventions, iRAP ratings can rise from 1-2 stars to 3 stars.
- *Crash reduction:* Actions could result in a 50% decrease in crashes that cause fatalities and major injuries.

5.0 Conclusion

The Star Rating system assesses road safety based on user protection rather than the number of crashes or fatalities. This study evaluated road safety from Bhujbal Vasti Chowk to Sus Road, Baner, dividing the corridor into 100-meter segments for accurate analysis using the Star Rating Demonstrator. Key factors assessed included roadside features, traffic flow, VRU infrastructure, and speed data. Recommended countermeasures aim to achieve a minimum 3-star rating for all users, focusing on improved road markings, pedestrian crossings, barriers, speed control, and visibility. Continuous monitoring with data analytics is emphasized for long-term effectiveness.

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